

AMENDMENTS TO THE CLAIMS

Listing of claims:

This listing of claims replaces all prior versions of claims in the application.

1. (Currently Amended): A residual stress improving apparatus for piping, arranged to irradiate an outer peripheral surface of piping having a straight pipe portion with laser light, comprising:

a laser head portion holding at least one laser head ~~or a plurality of the laser heads~~ for delivering the laser light;

circumferential direction moving ~~means for~~ unit moving the laser head, together with the laser head portion, along the outer peripheral surface of the straight pipe portion, and along a circumferential direction about a pipe axis of the straight pipe portion; and

reflection direction adjusting unit adjusting an orientation of the laser head in a plane intersecting the pipe axis of the piping to adjust a direction of delivery of the laser light in the plane, thereby adjusting a direction of reflection of the laser light so that the laser light reflected by the outer peripheral surface of the piping does not return to the laser head.

2. (Cancelled):

3. (Currently Amended): The residual stress improving apparatus for piping according to claim 1, ~~further comprising wherein~~

the reflection direction adjusting ~~means for adjusting~~ unit adjusts an orientation of the laser head in a plane ~~intersecting~~ orthogonal to the pipe axis of the piping to adjust a direction of delivery of the laser light in the plane, thereby adjusting a direction of reflection of the laser light so that the laser light reflected by the outer peripheral surface of the piping does not return to the laser head.

4. (Currently Amended): The residual stress improving apparatus for piping according to claim 1 ~~any one of claims 1 to 3, characterized in that~~ wherein

the piping has the straight pipe portion, and a bending pipe portion continued from the straight pipe portion, and wherein

an orientation of the laser head is adjusted in a plane including the pipe axis of the piping, whereby a direction of delivery of the laser light is adjusted in the plane so that an outer peripheral surface of the bending pipe portion located forwardly, in a direction of the pipe axis, of the laser head is irradiated with the laser light.

5. (Currently Amended): The residual stress improving apparatus for piping according to claim 1 ~~any one of claims 1 to 3, characterized in that~~ wherein

the piping has the straight pipe portion, and a bending pipe portion continued from the straight pipe portion, and wherein

the residual stress improving apparatus for piping further comprises delivery direction adjusting ~~means for~~ unit adjusting an orientation of the laser head in a plane including the pipe axis of the piping, thereby adjusting a direction of delivery of the laser light in the plane so that an outer peripheral surface of the bending pipe portion located forwardly, in a direction of the pipe axis, of the laser head is irradiated with the laser light.

6. (Currently Amended): The residual stress improving apparatus for piping according to claim 4, further comprising:

pipe axis direction moving ~~means for~~ unit moving the laser head portion along the pipe axis direction, thereby making it possible to adjust a position of irradiation with the laser light on the outer peripheral surface of the bending pipe portion.

7. (Currently Amended): The residual stress improving apparatus for piping according to claim 4, further comprising:

oscillating ~~means for~~ unit moving the laser head in an oscillatory manner along the pipe axis direction; and

output adjusting ~~means for~~ unit adjusting an output of the laser light so that the laser light delivered from the laser head at each oscillation position of the laser head has a uniform irradiation intensity on the outer peripheral surface of the bending pipe portion.

8. (Currently Amended): The residual stress improving apparatus for piping according to claim 4, ~~characterized in that~~ wherein

a plurality of the laser heads are arranged along the pipe axis direction, and wherein the residual stress improving apparatus for piping further comprises output adjusting ~~means for~~ unit adjusting an output of the laser light so that the laser light delivered from each of the plural laser heads has a uniform irradiation intensity on the outer peripheral surface of the bending pipe portion.

9. (Currently Amended): The residual stress improving apparatus for piping according to claim 1 ~~any one of claims 1 to 3, characterized in that~~ wherein

the piping has the straight pipe portion, and a bending pipe portion continued from the straight pipe portion, and wherein

the residual stress improving apparatus for piping further comprises pivoting ~~means for~~ unit pivoting the laser head portion about a pivot center in a plane including the pipe axis, the pivot center being a pivot shaft located on a rearward side, in a direction of the pipe axis, of the laser head portion, thereby making it possible to bring a forward side, in the pipe axis direction, of the laser head portion close to and away from an outer peripheral surface of the bending pipe portion.

10. (Currently Amended): The residual stress improving apparatus for piping according to claim 9, further comprising:

pipe axis direction moving ~~means for~~ unit moving the laser head portion along the pipe axis direction, thereby making it possible to adjust a position of irradiation with the laser light on the outer peripheral surface of the bending pipe portion.

11. (New): A residual stress improving apparatus for piping, arranged to irradiate an outer peripheral surface of piping having a straight pipe portion with laser light so as to heat the piping, comprising:

a laser head portion in which a plurality of laser heads for delivering the laser light are slidably provided to a slide member arranged in parallel to a direction of a pipe axis of the straight pipe portion; and

a circumferential direction moving unit moving the laser head, together with the laser head portion, along the outer peripheral surface of the straight pipe portion and along a circumferential direction along the pipe axis of the straight pipe portion.

12. (New): A residual stress improving apparatus for piping, arranged to irradiate an outer peripheral surface of piping having a straight pipe portion with laser light so as to heat the piping, comprising:

a laser head portion holding at least one laser head for delivering the laser light; and

a circumferential direction moving unit moving the laser head, together with the laser head portion, along the outer peripheral surface of the straight pipe portion and along a circumferential direction about a pipe axis of the straight pipe portion,

wherein the piping has the straight pipe portion and a bending pipe portion continued from the straight pipe portion, and

wherein the residual stress improving apparatus for piping comprises:

a pivoting unit pivoting the laser head portion around a pivot center in a plane including the pipe axis, the pivot center being a pivot shaft located on a rearward side, in a direction of the pipe axis, of the laser head portion, thereby making it possible to bring a forward side, in the pipe axis direction, of the laser head portion close to and away from an outer peripheral surface of the bending pipe portion;

a pipe axis direction moving unit moving the laser head portion along the pipe axis direction, thereby making it possible to adjust a position of irradiation with the laser light on the outer peripheral surface of the bending pipe portion; and

a driving control device making control such that

when the laser light is irradiated onto an outer peripheral surface having a smaller curvature radius of the bending pipe portion, interference between the laser head and the outer surface of the bending pie portion is prevented by pivoting the laser head portion by use of the pivoting unit so as to move the laser head portion away from the outer peripheral surface of the bending pipe portion, and by moving the laser head portion to the side of the straight pipe portion,

when the laser light is irradiated onto an outer peripheral surface having a larger curative radius of the bending pipe portion, the laser head portion is prevented from moving too far away from the outpour peripheral surface of the vending pipe portion by pivoting the laser head portion by use of the pivoting unit to bring the laser head portion closer to the outer

peripheral surface of the bending pipe portion, and by moving the laser head portion to the side of the bending pipe portion.

13. (New): A residual stress improving apparatus for piping arranged to irradiate an outer peripheral surface of piping having a straight pipe portion with laser light so as to heat the piping, comprising:

a laser head portion holding at least one laser head for delivering the laser light;

a circumferential direction moving unit moving the laser head, together with the laser head portion, along the outer peripheral surface of the straight pipe portion and along a circumferential direction about a pipe axis of the straight pipe portion;

an oscillating unit moving the laser head in an oscillatory manner along the pipe axis direction; and

a delivery direction adjusting unit adjusting an orientation of the laser head in a plane including the pipe axis of the piping, thereby adjusting a direction of delivery of the laser light in the plane so that an outer peripheral surface of the bending pipe portion located forwardly, in a direction of the pipe axis, of the laser head is irradiated with the laser light,

wherein the oscillating unit is a linear motor while the delivery direction adjusting unit is a tilt drive motor,

the laser head portion includes a stationary portion of the linear motor, the stationary portion being arranged in parallel to the pipe axis direction, and a moving portion of the linear

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motor, the moving portion moving along the linear motor fixing portion in the pipe axis direction,
and

the laser head is attached to the linear motor moving portion via the tilt drive motor.